Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_

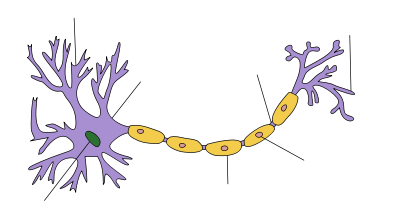
**Unit 9 Textbook Notes: The Nervous System (Chapter 48)**

Ms. Ottolini, AP Biology, 2012-2013

***Organization of the Nervous System***

1. What is the overall function of the nervous system?
2. How do simple animals like cnidarians (ex: jellyfish) organize their nervous system differently from more complex animals?
3. How is the central nervous system (CNS) different from the peripheral nervous system (PNS)?
4. Describe the function and location of the following types of neurons: sensory neurons, interneurons, and motor neurons.
5. Provide a basic explanation of the knee-jerk reflex. Identify the types of neurons and body structures involved.

|  |  |
| --- | --- |
| **Structure** | **Function** |
| Cell body |  |
| Nucleus |  |
| Dendrites |  |
| Axon |  |
| Schwann Cell |  |
| Axon terminal |  |

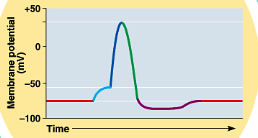
1. Label the following parts of the neurons pictured below: cell body, nucleus, dendrites, axon, Schwann cell (forms the myelin sheath), axon terminal (aka synaptic terminal). Describe function of each structure in the chart below. 

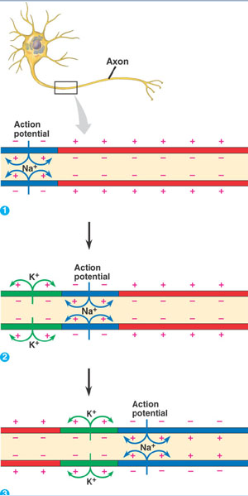
***Sending Signals down a single Neuron (via Action Potential)***

1. What is membrane potential? How do scientists measure membrane potential using a microelectrode?
2. Define resting potential. Why do we consider a neuron “polarized” when in a resting state?
3. Describe Na+ and K+ ion concentrations inside and outside of the neuron at resting potential.
4. Describe the difference between the three types of gated ion channels: stretch-gated ion channels, ligand-gated ion channels, and voltage-gated ion channels.
5. Why is an axon potential response considered an “all or nothing phenomenon?” What type of change in membrane potential will cause an action potential?
6. Draw lines to connect each step in the action potential (listed in order) with the appropriate image and step name.

|  |  |  |
| --- | --- | --- |
| **Step** | **Image** | **Name** |
| Activation gates on gated ion channels are closed and the membrane’s resting potential is maintained at approximately -70 mV. |  | Depolarization |
| Depending on the type of neuron, stretch-gated ion channels or ligand-gated ion channels will open in response to a stimulus, causing an Na+ influx into the cell. This reduces the negative charge inside the cell. If the membrane potential reaches the threshold, it triggers an action potential |  | Undershoot |
| Activation gates on voltage-gated Na+ channels open in response to depolarization and allow the influx of even more Na+ ions, creating a positive membrane potential. |  | Falling phase of the action potential |
| Na+ inactivation gates close, preventing influx of Na+ ions. K+ activation gates open, causing efflux (loss) of K+ ions from the cytosol.  Loss of positive charge causes repolarization of the neuron and causes the inside of the cell to again become negative in comparison to the outside of the cell. |  | Rising phase of the action potential |
| Both activation and inactivation gates on Na+ channels are closed. K+ activation gates close SLOWLY. This slow response causes the membrane potential to dip slightly below the resting potential. Eventually the membrane returns to its resting state by the action of the sodium-potassium pump (Na+ / K+ pump), which pumps 3 Na + out and 2 K+ in using energy from ATP. |  | Resting state |

1. Name and number each step on the action potential graph shown below. Use the names given in the right-hand column of the chart above.



1. In your own words, describe what is occurring at each step of action potential movement along the axon in the image to the right.

***Step 1:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Step 2***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Step 3:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Why can’t another action potential be created right away in the same neuron? Use the term refractory period in your answer.
2. How do the Schwann cells improve the efficiency of action potential movement down the axon? Use the terms myelin sheath, node of Ranvier, and salutatory conduction in your answer.

***Communication between Neurons***

1. What is the difference between an electrical synapse and a chemical synapse?
2. Order the events involved in synaptic transmission in the proper sequence (#1-7)

\_\_\_\_\_Ligand-gated ion channels on the post-synaptic membrane open in response to binding of calcium ions and allow Na+ to enter the cell, triggering depolarization / action potential in the post-synaptic cell

\_\_\_\_\_The action potential signal depolarizes the axon terminal membrane and opens voltage-gated calcium (Ca2+) ion channels

\_\_\_\_\_Synaptic transmission ends when the neurotransmitter diffuses out of the synaptic cleft, is reabsorbed by the pre-synaptic cell, or is degraded by enzymes in the synaptic cleft

\_\_\_\_\_Calcium ions rush into the axon terminal and are packaged in synaptic vesicles

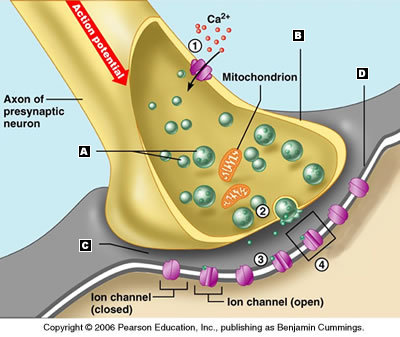
\_\_\_\_\_Synaptic vesicles fuse with the axon terminal membrane and release calcium ions (the neurotransmitter) into the synaptic cleft.

\_\_\_\_\_Calcium ions diffuse across the synaptic cleft and bind to ligand-gated ion channels on the post-synaptic membrane (dendrite membrane)

\_\_\_\_\_The axon terminal of the pre-synaptic neuron receives an action potential signal

1. Label the following structures / molecules on the synapse image given below: voltage-gated calcium channels, synaptic vesicles, axon terminal, post-synaptic membrane, calcium ion in synaptic cleft, ligand-gated ion channel

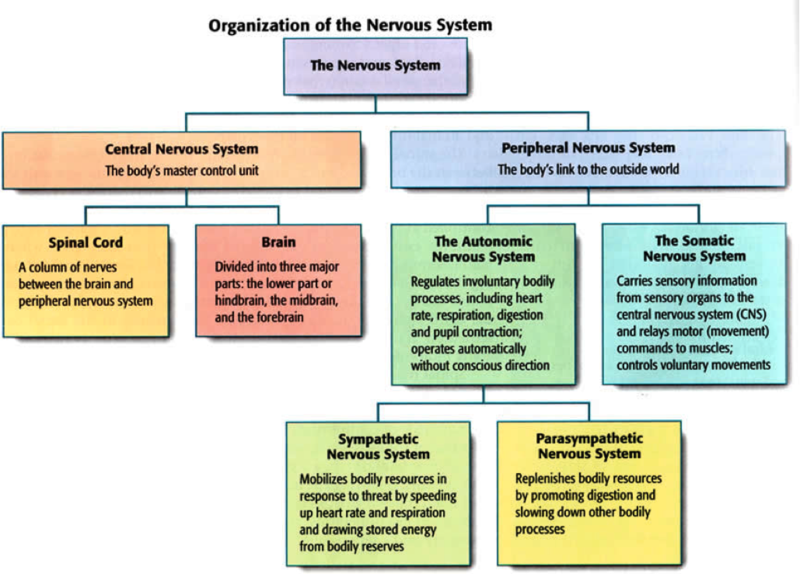
*\*\*\*Ignore the letters and numbers given on the image\*\*\**



1. What is the difference between excitatory postsynaptic potentials (EPSPs) and inhibitory postsynaptic potentials (IPSPs)?
2. Discuss the role of the acetylcholine neurotransmitter in the human body. What types of cells serve as acetylcholine’s presynaptic and postsynaptic cells?
3. Certain types of snake venom can block the active site on acetylcholinesterase, an enzyme found in the synaptic cleft that breaks down acetylcholine. If acetylcholine cannot be broken down, what effects might occur in the human body?

***Organization of the Nervous System (continued)***

1. Within the peripheral nervous system, there are two divisions – the somatic nervous system and the autonomic nervous system. What is the difference between these two divisions?
2. Within the autonomic nervous system, there are two main divisions – the sympathetic division and the parasympathetic division. Describe the basic role of each division.
3. A concept map showing the breakdown of the central and peripheral nervous systems is given on the next page.



1. ***The Central Nervous System***: fill in the names of all structures described in the outline below using the terms provided in the word bank.

|  |  |  |
| --- | --- | --- |
| Parietal Lobe | Medulla oblongata | Motor Cortex |
| Occipital Lobe | Cerebral cortex | Pons |
| Frontal Lobe | Cerebellum | Somatosensory Cortex |
| Temporal Lobe | Corpus Callosum | Lymbic System |

**Spinal Cord:** Receives information from the skin and muscles and sends out motor commands for movement

**Brain:** *There are three parts to the adult human brain – the hindbrain, midbrain, and forebrain. We will concentrate on the hindbrain and forebrain.*

1. **The Hindbrain**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Controls the autonomic nervous system
* \_\_\_\_\_\_\_\_\_\_\_\_: Assists the medulla in its activities, especially breathing
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Coordinates movement and balance

1. **The Forebrain (aka cerebrum)**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: An ancient system associated with emotions, instincts, and long-term memory formation ; includes the thalamus, hypothalamus, amygdale, and hippocampus
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: The largest and most complex part of the human brain (the outer portion of the cerebrum)
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: The tissue that connects the left and right cerebral hemispheres (sides) of the brain
* The four lobes of the cerebral cortex:

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Responsible for judgment and reasoning
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Responsible for the senses of hearing and smell
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Responsible for vision
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Responsible for spatial understanding and balance/orientation

* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extends across the back portion of the frontal lobe and is responsible for movement
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extends across the front portion of the parietal lobe and is responsible for sensing tactile (touch) stimuli

